Development of a Mobile Service on a WiFi Network for the Evaluation of Mathematical Skills

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ABSTRACT

This paper describes the design and development of a mobile service to make practical assessments of different topics of mathematics in order to improve the skills of students in high school education.

This tool has the ability to create user accounts for participants, as well as storing statistics about their practices with the purpose of giving students feedback of the subjects evaluated.

The mobile application was developed natively for the Android platform because of the advantages offered by this technology such as access to platform resources in a straightforward manner, coupled with benefits provided by current complementary tools such as PHP, JSON, MySQL and WiFi wireless technology.

Keywords: *mobile service, high school education, Android platform, feedback, evaluation of mathematical skills.*

1. Introduction

Teaching/learning mathematics in Mexico has been recognized by the Ministry of Public Education (SEP) as one of the main problems in elementary, secondary and higher education. Particularly, one of the primary concerns for institutions of high school level in our country is the development of skills to solve mathematical problems; the above can be observed from the results of tests called ENLACE and EXANI which are used as parameters of students' proficiency in problem solving and mathematical skills. Upon analysis of the tests performed in 2010, we can see that in terms of mathematical ability, 40.6% of students who took the test that year are in the insufficient level, 39.1% at the elementary level and the rest (20.4%) in the good and excellent levels [1].

Considering the above, in order to make an improvement, the teacher must not only justify the learning mode of students with his/her presence, but he/she must justify the development and feedback in their learning. Thus, the duty of the teacher is to improve the way of educating or improve his/her tools if he/she considers them inappropriate for use in the process.

Moreover, in technology it is considered that mobile learning is one way of addressing our problems in education. Devices such as smartphones and tablets enable innovation and help students, teachers, and students' parents to access digital content and personalized advice. Mobile devices, used in conjunction with 3G/4G wireless connectivity, are essential tools to improve student learning [2].

[3] defines a mobile service (m-service) as an application that is accessible from mobile clients over wireless networks. These services offer several benefits compared with their counterparts which use cables. First of all, mobile services fall into the category of access to services "anytime, anywhere". Users are not required to sit in front of their desktops to run their activities inasmuch as wireless technologies (such as WiFi, WiMax, CDMA, and HSDPA) provide enormous benefits to local users by connecting to a service provider. These are considered advanced technologies which introduce connectivity and Internet to rural areas [4].

With respect to development tools, the use of Android has increased considerably since its beginning of operation (2008) in the academic community thanks in part to the large number of mobile devices that they cover. The Android platform is open-source and the process for developing applications is friendlier than competing platforms. Additionally, the distribution of Android applications is more flexible in the development and accessible to device resources [5].

Regarding development methodologies of mobile applications, those considered useful for agile development are D-mobile [6], which was conceived in a period of rapid growth in the field of mobile applications and it is based on other well-known and well consolidated solutions such as eXtreme Programming (XP), Crystal metodologías and Rational Unified Process (RUP) [7]. This work, which is funded by the Faculty of Mathematics, University of Yucatan, Mexico as an internal project of Computer Science Department (CA-FMAT-92), describes a proposal to encourage the development of mathematical ability with the design and development of a mobile tool whose practical utility is to give to high school students an

opportunity to practice math exercises designed by the instructor. The application has been designed in such a way that it may be adapted to any subject in the curriculum of any high school program. One of our main objectives is to describe the inclusion of mobile technologies as an alternative that is currently impacting high school level institutions as well as the way we intend to implement it using the advantages that smartphones and wireless networks provide.

This work is described in the following sequence: After this introductory section we have a section with a description of mobile technology use in education, where we make special emphasis on teaching/learning mathematics. Below we have a section describing the design and development of the mobile service, which is the core topic of this work. Then, the obtained results and some additional considerations for implementation are described. Finally, we describe the tasks in progress and future works.

2. Mobile Technology in Education

There are several mobile applications adopted by educational institutions around the world. A series of tools that have generated benefits or have the potential to do it in the medium and long term is described.

[8] describes a study to investigate whether PDA's can improve clinical and pharmacological background knowledge of students and to identify issues associated with the use of such devices in clinical experiences of students. Students using PDA's showed a moderate increase in their average scores and it was found that their use is beneficial in learning in the clinical area.

In [9] preliminary results of activities carried out using smartphones and mobile services in classrooms at a university are described. The purpose of the study was to explore and identify what content and services could be suitable to mobile devices in order to support learning and communication of university students. This study found that services are useful for student learning and attitudes are more positive if the instructor adapted his pedagogical style and instructional material to devices in order to take advantage of the distinctive capabilities of multicasting.

[10] describes the development of an application based on mobile services to support tutorial activity for university students considering mentoring as a process of support in their academic lives. One of the main aspects of the study was an analysis of trends in students regarding the problems that take place throughout their academic career.

In [11] a possible solution based on mobile technology to the problem of low performance in Mathematics in the Caribbean was presented. In this study, although the results did not reveal a significant difference between traditional learning and learning assisted by mobile technology, a lot of excitement was generated in students by incorporating these practices for their benefit.

With this, we consider that the available information from working with mobile services in education provides the foundation and confidence to have success in creating such environments inasmuch as the institutions adopting these technologies have paved the way, allowing us to follow in their footsteps and improve on their solutions.

3. Design and Development of Mobile Service

The design and development of this mobile service was made considering a methodology named D-mobile [6] and further using a partial participatory approach, i.e. involving only teachers in the different phases. Below, design and implementation considerations of the service are described.

3.1 Users of the tool

The service is intended for two types of users: teachers (administrators) and students (users). To this end we decided to include in the system two different actors for the interface management to those users: Administrator and User. The need for access to information anytime and anywhere within an institution triggered the design on both actors for use on smartphones. For an administrator it is important to be able to manage information about subjects, and to evaluate them in an organized and efficient way. For a user it is important to have reliable service availability to perform his/her practices and view his/her statistics in order to improve his/her skills in the various topics. Basically if an actor is located at any point within the institution, using the WiFi network he/she can use the application to send requests to the mobile service, which then sends the appropriate response to his/her counterpart.

3.2 Functions of the mobile service

Because it is an application with the aim of assisting practice to improve math skills, this mobile service only considers access control for the administrator. Thus, the student (user) can only view his/her own data and make his/her evaluation practices. In turn, the administrator will be responsible for managing users, generating statistics and providing technical support to mobile users. Fig. 1 shows use cases for administrator and user.

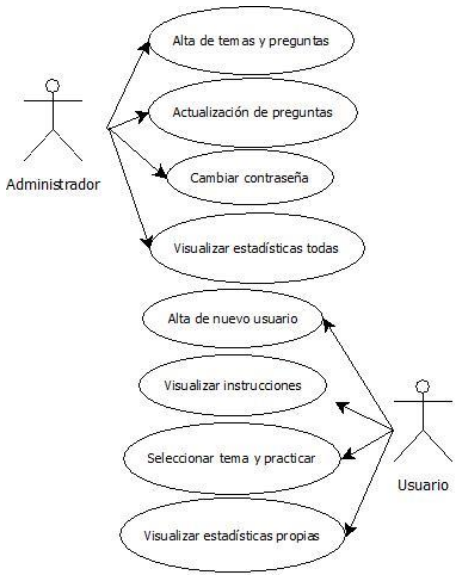

Fig. 1 UML use cases diagram of mobile service

Next each of the use cases provided by the mobile service are described. In particular, for the Administrator we have the following:

- Registering topics and their questions. In this module the administrator carries out the process of registering math topics and their related questions as well as their respective responses.
- Updating questions. This module allows us to update the statements of both questions and their respective answers.
- Updating administrator password. This module allows us to change the administrator password once a user is identified through the current password.
- Displaying the background of users. This module allows us to consult entries and statistics of all users who have accessed the service regarding their practices in the application.

Also, the user modules provided by the mobile service are the following:

- Registering users. This module asks a new user his/her data for a registration process in order to get access to the application.
- Seeing instructions. In this module we can display the necessary instructions for the practical assessment.
- Selecting topics and practicing. Core service module in which the student will be able to practice pre-selecting a required item.
- Displaying user history. This module allows users to check the statistics of the user currently practicing.

3.3 Using JSON in the service implementation

Due to the requirement of sending information over the wireless network, the server application processes were developed in PHP using JSON format. JSON means JavaScript Object Notation, which is a simple format, easy to read and write for a wide range of scripting languages and may represent data in a structured way [12]. For example, if you want to represent a data set as follows:

message

-english: "Sending data"

-spanish "Enviando datos"

In JSON, this could be represented as follows:

{"message": {"Inglés": "sending data", "spanish": "enviando datos"}}

The following PHP code (called Consulta.php) get the names and IDs of mobile users which are encoded in the JSON format to return them via a WiFi network:

```
<?php
require_once __DIR__ . '/Coneccion.php';
$db = new DB_CONNECT();
$nombre=array();
$id=array();
$consulta=mysql_query("select * from usuario;");
if(mysql_num_rows($consulta)>0){
  while($Dat=mysql_fetch_array($consulta)){
                    $nombre[]=$Dat["nombre"];
                    $id[]=$Dat["idUser"];
  }

  $out["nombre"]=$nombre;
  $out["id"]=$id;
  $js=json_encode($out);
  echo $js;
}
?>
```

4. Interfaces and Development

The interfaces were developed with the Android development kit that includes the use of XML [13]. For connection from Android applications granting access permissions on the internet android.manifest project file, the following code was necessary:

<uses-permission

android: name = "android.permission.INTERNET" />

After making a connection to MySQL server data it is necessary for the administrator (teacher) to generate topics and questions which are required for the user to make their assessment practices. So, the questions insertion module includes a XML interface shown in Fig. 2, in which it is possible to describe each of the questions of a selected topic.

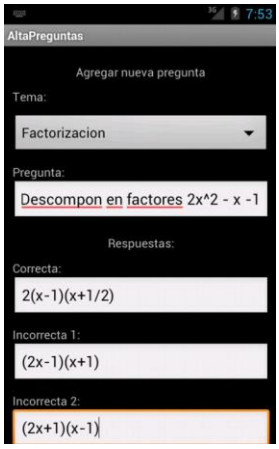

Fig. 2 Questions' insertion interface

Also, the interface asks for a correct answer and three incorrect answers, which will come in every practice in random order. As an added design feature a minimum number of questions for each topic were defined, ie, the administrator must decide how many questions are on each practice assessment of an issue and configure the application so that this practice can be carried out, otherwise it may not start. Fig. 3 shows a user interface that is presented to users upon registration (or access) in order to select a registered user and start a practice, or create a new one (if he/she is accessing for the first time).

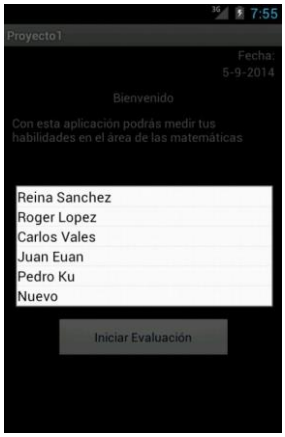

Fig. 3 Start of practice interface

Fig. 4 shows the interface presented to the user subsequent to his/her access in order to initiate a practice. To start the practice the user must select one of the topics identified by the teacher. Also on the same interface he/she has options to view the instructions for a practice or view his/her history.

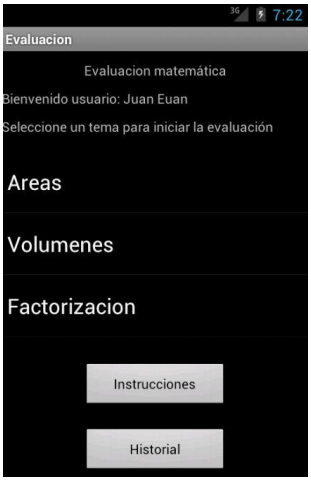

Fig. 4 Theme selection Interface

By selecting a specific topic, a practice starts. A series of questions is generated with answers (one correct and three incorrect) as shown in Fig. 5.

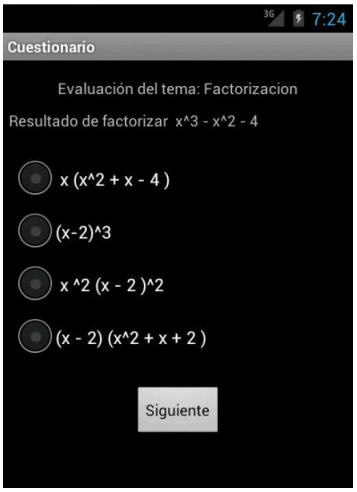

Fig. 5 Evaluation Practice Interface

The list of questions (and the answers of a particular topic) are obtained from the data server via a call to a script (consultaPreguntas.php), which retrieves the respective questions and answers from a specified topic from MySQL database [14] located in an http server. In the following fragment of code, an access to the database, the recovery of the questions and answers of a given subject (variable $tema) and its codification in JSON format are shown:

```
$consulta=mysql_query("select * from preguntas where tema='$Tema';");
if(mysql_num_rows($consulta)>0){
  while($Dat=mysql_fetch_array($consulta)){
                    $pregunta[]=$Dat["pregunta"];
                    $correcta[]=$Dat["correcta"];
                    $incorrectauno[]=$Dat["incorrectaUno"];
                    $incorrectados[]=$Dat["incorrectaDos"];
                    $incorrectatres[]=$Dat["incorrectaTres"];
  }
  $out["pregunta"]=$pregunta;
  $out["correcta"]=$correcta;
  $out["incorrectaUno"]=$incorrectauno;
  $out["incorrectaDos"]=$incorrectados;
  $out["incorrectaTres"]=$incorrectatres;
  $js=json_encode($out);
  echo $js;
}
```

The following Android-code fragment shows the recovery of transmitted data from the server to the application (for Fig. 5 Interface):

```
String datos=conexion.executeHttpPost("consultasPreguntas.php", postValores);
JSONObject ObJ=null;
JSONArray Jpregunta = null, Jcorrecta = null, Jincorrectauno = null, Jincorrectados
= null, Jincorrectatres = null;
try {
  ObJ=new JSONObject(datos);
} catch (JSONException e) {
  Toast.makeText(getApplicationContext(), "Error al leer   el objeto json",
Toast.LENGTH_SHORT).show();
  finish();
}
try {
  Jpregunta= ObJ.getJSONArray("pregunta");
  Jcorrecta= ObJ.getJSONArray("correcta");
  Jincorrectauno=ObJ.getJSONArray("incorrectaUno");
  Jincorrectados=ObJ.getJSONArray("incorrectaDos");
  Jincorrectatres=ObJ.getJSONArray("incorrectaTres");
} catch (JSONException e) {
  Toast.makeText(getApplicationContext(), "Error al leer el Arreglo json",
Toast.LENGTH_SHORT).show();
  finish();
}
cont=Jpregunta.length();
if(Jpregunta.length()>0){
  preguntas=new String[Jpregunta.length()];
  correctas=new String [Jpregunta.length()];
  incorrectas1=new String [Jpregunta.length()];
  incorrectas2=new String [Jpregunta.length()];
  incorrectas3=new String [Jpregunta.length()];
  try {
    for(int i=0; i<Jpregunta.length();i++){
      preguntas[i]=Jpregunta.get(i).toString();
      correctas[i]=Jcorrecta.get(i).toString();
      incorrectas1[i]=Jincorrectauno.get(i).toString();
      incorrectas2[i]=Jincorrectados.get(i).toString();
      incorrectas3[i]=Jincorrectatres.get(i).toString();
    }
  } catch (JSONException e) {
  Toast.makeText(getApplicationContext(), "Error al obtener los elementos, verifica
tu conexion", Toast.LENGTH_SHORT).show();
  finish();}
}else{
  Toast.makeText(getBaseContext(), "No existen preguntas",
Toast.LENGTH_SHORT).show();
}
```

As mentioned above, each user has access to a section of his/her own statistics, which are stored as a record for each developed practice. Each of the practices is considered a game and its results are stored in the relationship Partida, which has the scheme shown in Fig. 6. For each item the service consideres: a user identifier number (unique), a tested subject, the number of attempts for a certain subject, and their respective numbers of successes and failures.

idPartida	idUser	tema	intentos	aciertos	errores
3	8	Areas	1	0	6
4	9	Areas	2	2	10
5	13	Areas	1	2	4
6	14	Factorizacion	1	5	1

Fig. 6 Schema of the Partida relationship

The reason for showing the users their statistics is to measure the improvement in their skills in each topic. In case of the administrator, he will have access privileges to the statistics of all users in order to show the best of each user and analyze his/her deficiencies to take appropriate actions.

5. Results and Additional Considerations

For the test phase we selected two high schools with different characteristics, this was due to the assumption of a marked difference in math skills. The first is a private school and the second a public. Currently we are determining the sample size for teachers and students to perform both qualitative and quantitative assessments regarding satisfaction and usefulness of the application on its final location.

Among the advantages that we consider will provide the implementation of mobile service are:

- Collecting quantitative user information in a timely manner to take actions if needed.

- Making teachers aware of the advantages of mobile phones as an aid in the development of tasks in an effective and efficient form. In [15] it is considered that teachers have some fear of being outdated if they not learn to use these applications, as they have no doubt that the use of technology resources gives a great professional help.

Among the possible disadvantages of its implementation that we could find in a fraction of users are:

- Initial disinterest by teachers in the use of mobile technologies for improving math skills of their students.
- Initial disinterest by students in the use of mobile technologies for improving their math skills.

Finally, we consider that some actions and attitudes are necessary for successful implementation of mobile service in this institution:

- A timely response. The teacher must be able to respond quickly in the event that the user does not make a significant improvement in a specific skill. The teacher's answer should preferably include some personal suggestions and / or support to the student.
- Self-criticism. The student must have criticism if he/she is not being responsible enough in using the tool inasmuch as it would not be useful if he/she only focuses on assessments in the mobile service regardless of practicing outside the application. If used incorrectly could cause disinterest in both teacher and student.
- Reliable feedback. It is not enough to simply generate an adequate amount of questions in the application for the preparation of the student; the teacher should spend time analyzing stats and provide feedback to students in order to create a climate of trust with them, avoiding feelings of detachment or isolation among students and highlighting their achievements and progress in the subjects evaluated.

6. Conclusions and Future Work

In this paper we have described mobile services used by organizations around the world and presented the design and development of a mobile service as support tool for improving math skills using Android technology conjugated with PHP, JSON and MySQL on a WiFi network. This application is the halfway point in our institution in the process of evaluating emerging technologies and raising awareness in our academic community about mobile technology benefits complemented with wireless networks in our daily activities.

We believe that the primary contribution of this work will be perceived in the short term as it will enable the quantifying the improvement of math skills and raise interest of students in institutions of our region. This would impact not only on students also in the way that teachers teach and evaluate.

As part of future work, it is clear that a plan for monitoring and continuous improvement is necessary for this mobile service because it does not suffice to describe how it works, but whether it is serviceable and useful. Additionally, we consider that this mobile service could be customized for different topics, so another future work will make it a configurable tool to other areas.

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